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SEED STORAGE SURVEY IN NORTHERN TANZANIA



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DISCLAIMER

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Feed the Future Consortium Partners in the Feed the Future Global Supporting Seed Systems for Development activity:



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I. Executive Summary

As a S34D consortium partner, Purdue University implemented a seed storage survey to assess postharvest seed management of various grain value chain actors (farmers, agrodealers and seed producers) in Northern Tanzania in August 2019. The goal was to identify the current storage and protection practices of postharvest management of seed of farmers, agrodealers, and seed producers and to identify potential causal factors of those practices. The surveys of farmers and agrodealers were implemented in four districts within two regions of Tanzania: the Kilimanjaro Region (Hai and Siha Districts) and the Manyara Region (Mbulu and Babati Districts). The seed producers' survey was implemented in the Arusha Region (Arusha town). A total of 464 farmers, 40 agrodealers, and 9 seed producers were interviewed during this survey.

Results

The results of the survey suggest that 91% of farmers purchase and do not store hybrid maize seed. However, 71% of farmers store bean seed of both local and improved varieties. Of the 40 agrodealers and eight of the nine seed producers, all store hybrid maize seed and improved bean seeds for less than six months (the ninth seed producer reported storing seed up to 12 months after harvest). Insects are the primary source of seed storage losses¹ among farmers (54% for maize and 51% for beans) but only about 33% for the seed producers. This is probably because seed producers report a much higher usage of insecticides (88%) compared to farmers (30%) and agrodealers (59%) for seed protection during storage. There is some awareness and use of hermetic storage technologies for seed preservation among farmers and agrodealers. Most farmers (92% for maize and 100% for beans) and seed producers (89%) rely on the sun for drying seed. There is a limited number of seed producers (22%) who are using either mechanical dryers or a combination of sun drying and mechanical dryers. Farmers rely on various methods for assessing moisture content—53% report biting. However, the majority of seed producers (67%) reported using moisture meters. Shockingly, 22% of seed producers reported biting as their normal method of testing moisture levels. There is a need for intervention to improve seed handling and storage both at the farm and seed producers' levels.

Recommendations

- Continue to promote the adoption of hybrid seed and improved bean seed varieties—farmers are investing money to buy improved genetic materials because they are benefiting from these varieties with increased food security and income. More than 91% of farmers purchased hybrid maize seed. Awareness building should also include training farmers to stop storing harvested hybrid maize seed for future planting.
- Strengthening private sector capacity in handling and storing seed (hybrid and improved bean seed varieties) is critical to enhancing the quality of seed being sold to farmers. The results show that 67.5% of agrodealers and 100% of seed producers store seed. Strengthening of the private sector should include increasing the availability of improved seed and hermetic storage technologies. Most farmers complain about the availability of hermetic technologies. Creating awareness among private sector actors (agrodealers and seed producers) about the business opportunities in selling hermetic technologies would help strengthen their working relationship with farmers. This would diversify the products being sold by these agrodealers to farmers and expand their businesses. In addition, if PICS bag vendors were provided the opportunity to sell seed, the retail networks of seed would be increased as well.
- Training farmers on proper handling and storage of local and improved bean varieties would increase the quality of genetic materials the farmers use for crop production as they recycle this seed (planting materials) for several seasons.

¹ Postharvest loss per crop was not captured in this survey.

II. Introduction

Feed the Future Global Supporting Seed Systems for Development activity (S34D) is a five-year Leader with Associates Cooperative Agreement Award, funded by the Feed the Future Initiative through the Bureau for Resilience and Food Security (RFS) and by USAID through the U.S. Office of Foreign Disaster Assistance (OFDA). Catholic Relief Services (CRS) is leading this consortium with support from partners that include: Agri Experience, CIAT-PABRA, IFDC, Opportunity International (OI) and Purdue University. S34D's Life of Activity (LOA) runs from August 2018 through August 2023. The overarching goal of S34D is to improve the functioning of national seed sectors in focus countries in an *inclusive* manner—this 'inclusive' approach aims to support all farmers, including women farmers and youth. S34D aims to meet the activity goals by increasing the capacity of each of the seed systems to sustainably offer quality, affordable seeds of a range of crops (**Objective 1**) and increasing collaboration and coordination among all seed systems actors and actions (**Objective 2**).

This activity is unique in that the overall strategy proposes to generate a broader view and integration of the seed systems, with **Objective 1** working across formal, informal and emergency seed sectors; and, **Objective 2**, placing emphasis on the interactions and synergies among the three systems. This integrated approach is further strengthened by cross-cutting IRs that seek to improve policies and practices that support pluralistic seed systems, rather than focusing on individual parts of each system. An important aspect of the activity is to gain a better understanding about how seed systems interact and where there may be positive or negative market interactions. In the case of detrimental actions, S34D intends to develop interventions to address market distortions.

Seed is the backbone of crop production. The importance of seed availability, quantity, quality, and access cannot be overemphasized. Worldwide, farmers are the primary source of seed for most crops (Louwaars and De Boef, 2012). During the planting season, farmers draw seed from either formal (agrodealers and producers) or informal sources (farmer-saved seed), depending on the crop (Sperling and Cooper, 2004). Government, international research institutions, private companies, and foundations are involved in crop breeding, seed multiplication, and seed dissemination. This seed is often regulated, resulting in high-quality seed. Agrodealers and sometimes development agencies (NGOs) make this seed available to farmers. In the informal sector, farmers produce seed through recycling (planting seed from previous seasons), which deteriorates the quality over time, often resulting in poorer yields (Morris et al. 1999). For example, in Zimbabwe, hybrid seed recycling resulted in 32% yield loss in the second generation, at which point open pollinated varieties outperformed the recycled hybrid seed (Pixley and Bänziger, 2004).

Seed storage in both formal and informal seed sectors plays a critical role in improving production and productivity, as well as food security (McGuire and Sperling, 2011). Postharvest handling of seed is key to maintaining high germination rates and vigor of planting materials. Seed viability during storage is affected by several factors including pest attacks, excessive humidity and high temperatures (Harrington and Kozlowski, 1972). In developing countries such as Tanzania, postharvest management of seed varies among actors along crop value chains. Farmers who cultivate legumes crops such as common beans tend to recycle their seed for several growing seasons. However, a large proportion of farmers who grow maize tend to rely on agrodealers to supply hybrid maize seed each planting season. There is limited knowledge in this region about where and how seed is handled among the crop value chain actors.

To gain more insight into these dynamics, Purdue University in collaboration with CIAT-PABRA, implemented a seed storage survey in Northern Tanzania to assess storage and postharvest management constraints and capacities among maize and bean value chain actors including farmers, seed producers and agrodealers. This survey was conducted in Northern Tanzania because Purdue University could leverage some ongoing efforts by CIAT-PABRA. CIAT-PABRA has several ongoing programs on beans and has been working with the National Agricultural Research System (NARS), private sectors, and farmers. The purpose of the survey was to understand how different seed actors

handled and stored seed after harvest. Emphasis was placed on seeds for major field crops in the region—maize and beans. The objective of this survey was to assess postharvest management practices (drying, moisture assessment and storage) of maize and bean seeds as they moved through the value chain from seed producers to agrodealers and finally to farmers.

III. Methodology

The survey on seed storage was implemented in collaboration with CIAT-PABRA and local NARS in Northern Tanzania between August 6 – 20, 2019.

1. Enumerator recruitment

Purdue recruited a local consultant to help with the recruitment of enumerators, refining the questionnaire, selection of survey sites and field logistics. Contact information and CVs of potential enumerators were collected. Enumerators with previous field data collection experience were interviewed. Six enumerators were selected and a Purdue staff member also worked as an enumerator. In total, there were seven enumerators involved in field data collection.

2. Survey site selection

For the survey of farmers and agrodealers, villages were selected from the Kilimanjaro Region (Hai and Siha) and the Manyara Region (Mbulu and Babati) (see Annex D). Nine seed producers (companies) were interviewed in Arusha Region (Arusha town) (see Annex D). Village is the smallest unit in the administrative structure of Tanzania and is therefore suitable as the primary sampling unit. The chosen regions were selected due to their production potential for maize and beans. The selected areas cover a range of altitudes suitable for cereal farming. In addition, this area was selected because CIAT-PABRA has ongoing activities on common beans in these locations.

Households were randomly selected from the appropriate villages proportionate to the number of farmers in the village. This was accomplished with the support of village extension officers. Within each selected village, 20-25 farm households were selected for a total of 450 (225 per region) farmers from the two regions. When the survey was conducted, some farmers were not present and it was necessary to increase the sample size in some villages. In general, the respondents were either the head of the household or spouse, or a representative member of the household who is actively involved in maize or bean production. A total of 464 farmers, 40 agrodealers and nine seed producers were interviewed.

3. Enumerator training

The training of enumerators was conducted on August 7, 2019 at the Selian Agricultural Research Institute (SARI), which hosts CIAT-PABRA. The training covered two components of the questionnaire: one for farmers and the other for the agrodealers and seed producers. After training, the questionnaire was edited based on comments and feedback from the enumerators. The final version of the questionnaire was used to collect data.

4. Survey

The survey was implemented in five different sites: Kilimanjaro Region (Hai and Siha districts); Manyara Region (Mbulu and Babati districts); and, the Arusha Region. The itinerary was as follows: Hai, August 9 – 10, 2019; Siha, August 12 – 13, 2019; Mbulu, August 14 – 15, 2019; Babati, August 16 – 17, 2019; Arusha, August 19 – 20, 2019. During the survey, each farmer was given a poster by the enumerators after the completion of the interview (see Annex A for a copy of the poster).

IV. Key Findings and Results

A. Farmers

1. Survey demographics

The survey questionnaire for farmers can be found in Annex B. Table 1 below shows demographic information of farmers interviewed during the survey in the four districts. The majority of farmers interviewed were male (71%), likely because males were more available during the time of the interviews. The age of respondents was distributed across all age brackets with more than 60% older than 40 years old. The majority had primary school education (82%). A large number did not belong to any farmer group (60%). About 10% of the farmers are part of the saving groups.

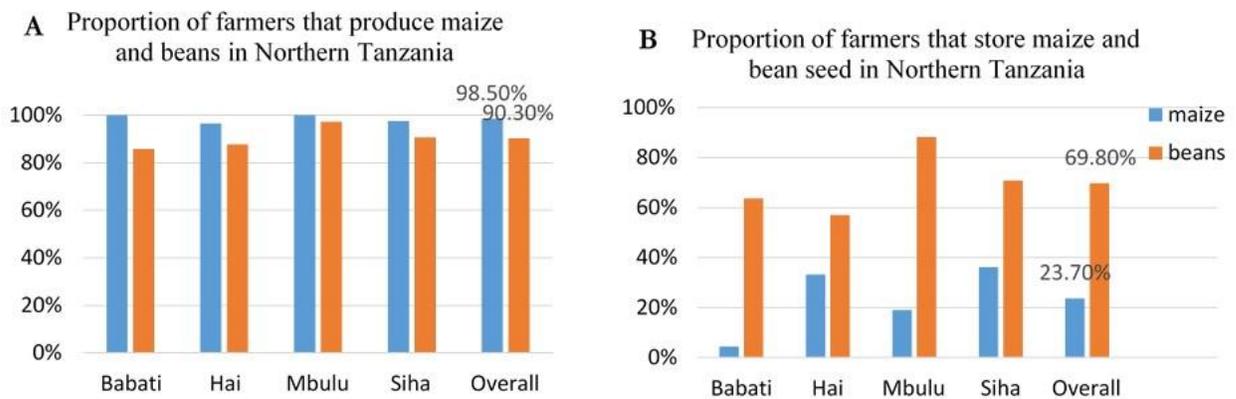
Table 1: Demographic information of farmers interviewed during the survey in the four districts in Northern Tanzania

| Variable | District | | | | Overall (n=464) |
|----------------|-------------------|----------------|------------------|-----------------|--------------------|
| | Babati (n=113) | Hai (n=114) | Mbulu (n=110) | Siha (n=127) | |
| Gender | | | | | |
| Female | 21.2% | 43.0% | 16.4% | 34.6% | 29.1% |
| Male | 78.8% | 57.0% | 83.6% | 65.4% | 70.9% |
| Age | | | | | |
| 18 to 30 years | 11.5% | 11.4% | 10.9% | 15.0% | 12.3% |
| 31 to 40 years | 23.0% | 28.9% | 31.8% | 18.9% | 25.4% |
| 41 to 50 years | 31.9% | 26.3% | 33.6% | 28.3% | 30.0% |
| Above 50 years | 33.6% | 33.3% | 23.6% | 37.8% | 32.3% |

Crops grown and seed storage

Although almost all farmers produce both maize (99%) and beans (90%), more farmers store bean seed (71%) than maize (24%). The quantity of maize produced is greater than the quantity of beans (see below). Most farmers purchase hybrid maize, therefore only a few store maize seed.

Figure 1: Proportion of survey respondents who are producing (A) and storing (B) seed in the four districts in Northern Tanzania.



2. Storage duration of seed

Table 2 shows storage duration of maize and bean seed saved by farmers in the four districts. For those who store maize seed, the farmers mainly store for 3-6 months (95%); beans are also stored for 3-6 months (92%).

Table 2: Storage duration of maize and bean seed saved by farmers in the four districts in Northern Tanzania.

| Variable | District | | | | |
|-----------------------------------|----------|-------|-------|-------|---------|
| | Babati | Hai | Mbulu | Siha | Overall |
| Storage duration Maize | | | | | |
| Less than 3 months after harvest | 0.0% | 5.3% | 0.0% | 0.8% | 1.5% |
| Between 3-6 months after harvest | 97.3% | 91.2% | 93.6% | 97.7% | 95.1% |
| Between 6-9 months after harvest | 2.7% | 1.8% | 4.5% | 0.8% | 2.4% |
| Between 9-12 months after harvest | 0.0% | 1.8% | 0.9% | 0.8% | 0.9% |
| More than 12 months after harvest | 0.0% | 0.0% | 0.9% | 0.0% | 0.2% |
| Storage duration Beans | | | | | |
| Less than 3 months after harvest | 0.0% | 1.8% | 0.0% | 3.9% | 1.5% |
| Between 3-6 months after harvest | 94.7% | 87.7% | 92.7% | 94.9% | 92.0% |
| Between 6-9 months after harvest | 2.7% | 7.9% | 3.6% | 1.6% | 3.9% |
| Between 9-12 months after harvest | 0.9% | 2.6% | 1.8% | 1.6% | 1.7% |
| More than 12 months after harvest | 1.8% | 0.0% | 1.8% | 0.0% | 0.9% |

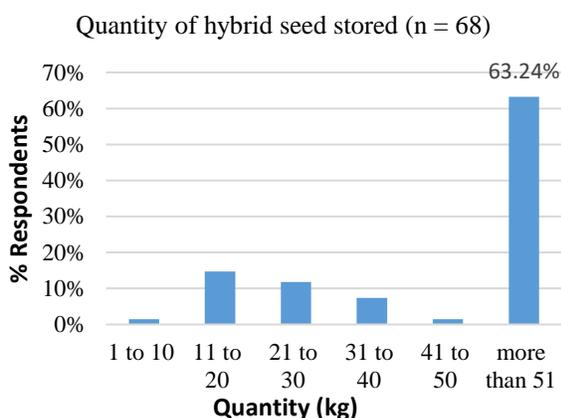
3. Quantities of maize and bean seed planted, stored, and grain produced by farmers

Table 3: Quantities of maize and bean seed planted, stored, and grain produced by farmers in the four districts in Northern Tanzania.

| Crops | Variables | n | Percentile | | | |
|-------|--|-----|------------------|------------------|------------------|------------------|
| | | | 25 th | 50 th | 75 th | 90 th |
| Maize | Quantity of maize seed planted | 457 | 8 | 16 | 24 | 48 |
| | Quantity stored- local maize varieties | 34 | 19 | 45 | 200 | 850 |
| | Quantity stored- Open pollinated maize varieties | 9 | 9 | 20 | 190 | 0 |
| | Quantity stored- hybrid maize varieties | 68 | 30 | 100 | 437 | 1500 |
| | Quantity of maize harvested | 457 | 882 | 1800 | 3150 | 6,000 |
| Beans | Quantity of bean seed planted | 419 | 20 | 35 | 60 | 100 |
| | Quantity stored- local bean varieties | 273 | 30 | 60 | 100 | 200 |
| | Quantity stored- improved bean varieties | 65 | 35 | 100 | 200 | 400 |
| | Quantity of beans harvested | 419 | 150 | 300 | 600 | 1,200 |

Table 3 shows that the vast majority of farmers (75%) planted less than 24kg of maize seed. Only about 25% of farmers stored any kind of maize seed; this supports the findings that most of them purchase hybrid maize. Farmers rely on markets, agrodealers, and seed producers to purchase their maize seed for planting. Almost one sixth of the farmers (68) stored hybrid seed and the vast majority

stored less than 200kg. Farmers saved seed from their produced hybrid maize grain. For beans, most farmers saved their seed for planting the next season. Among all farmers who planted beans, about 80.7% relied on their saved seed (local and improved varieties). Among farmers who stored bean for planting the following season, 65.2% saved local bean varieties compared to only 19.2% who saved improved bean varieties. Farmers produced a sizeable amount of maize with about 75% harvesting 3.2 MT or less; while for beans 75% of farmers harvested 0.6 MT or less.



4. Postharvest management and storage of seed by farmers

Table 4 shows that most farmers rely on the sun to dry both maize and bean seeds. All farmers use subjective methods to assess moisture content of seed before storage. A little over half of the farmers said that insects are the major sources of losses during maize and bean seed storage. It is important to note that 40% of farmers say they do not experience any storage losses. Farmers use a variety of storage methods and technologies to preserve their seed. About 80% of farmers either use insecticides (43.2%) or hermetic airtight methods (36.4%).

Table 4: Seed drying and moisture assessment methods, sources of losses and seed protection methods used by farmers in the four districts in Northern Tanzania.

| Drying methods | Maize (n=108) | Beans (n=324) |
|---|----------------------|----------------------|
| Sun dry | 91.70% | 100% |
| Hang indoors and outside (on walls, etc.) | 6.50% | |
| Indoor over cooking place (smoke) | 1.90% | |
| Moisture assessment | Maize (n=108) | Beans (n=324) |
| Biting the grain | 52.80% | 58.60% |
| Do not measure | 11.10% | 13.60% |
| Sound of shaken grain | 29.60% | 23.80% |
| Visual observation | 6.50% | 4.00% |
| Source of seed loss | Maize (n=108) | Beans (n=324) |
| Humidity/mold | 1.90% | 3.40% |
| Insects | 53.70% | 50.90% |
| No seed storage losses | 38.90% | 42.60% |
| Rodents | 5.60% | 3.10% |
| Seed protection methods | Maize (n=108) | Beans (n=324) |
| Botanicals (plant extract, etc.) | 0.90% | 1.20% |
| Do nothing | 4.60% | 6.50% |
| Hermetic/ airtight Methods | 52.80% | 36.40% |
| Pesticides/chemicals | 29.60% | 43.20% |
| House storage (smoking, seed in husks) | 3.70% | - |
| Traditional (underground storage, ash, smoke) | 8.30% | 12.70% |

5. Seed storage methods and technologies used by farmers

Table 5 below shows storage containers, their costs, and technologies used by farmers for maize and bean seed storage.

- **For maize:** Woven bags of about 97 kg capacity were most used at a cost of TZS. 920 (\$0.40) each. This was followed by PICS bags and metal silos of 100 kg and 164 kg capacity respectively, and cost of about TZS. 4,600 (\$2.00) and TZS. 30,150 (\$13.00), respectively.
- **For beans:** Woven bags of about 104 kg capacity were most widely used at a cost of TZS. 879 (\$0.38) each. Jerrycans were also used quite frequently and had a mean capacity of 20 kg and cost TZS. 3400 (\$1.48). PICS bags and metal silos followed at a capacity of 101 kg and 170 kg respectively, and cost of about TZS. 4650 (\$2.02) and TZS. 48100 (\$21), respectively.
- **Chemical use.** For maize seed, chemical use was practiced by 32 farmers with each farmer applying a unit of their chosen chemical to 160kg and paying TZS. 3518 (\$0.96/bag) for the chemical. For beans, chemical use was practiced by 140 farmers and each farmer applied a unit of their chemical to 230kg and paid TZS. 3897 (\$0.74/bag) for that chemical.

Table 5: Maize and bean seed storage and protection methods used by farmers in the four districts in Northern Tanzania

| MAIZE | | | BEANS | | |
|------------------------------|-------------------------|-------------|------------------------------|-------------------------|-------------|
| Storage Methods | Capacity (Kg)* | Cost (TZS)* | Storage Methods | Capacity (Kg)* | Cost (TZS)* |
| Woven bags (n=30) | 97.3 | 920 | Woven bags (n=160) | 103.9 | 879 |
| Jerry cans (n=15) | 37.3 | 5767 | Jerry cans (n=60) | 20.4 | 3400 |
| Barrels (n=16) | 152.5 | 37500 | Barrels (n=9) | 154.4 | 39222 |
| Metal Silos (n=20) | 164.0 | 30150 | Metal Silos (n=23) | 170.5 | 48100 |
| Clay pots (n=1) | 50.0 | 10000 | Clay pots (n=2) | 55.0 | 20000 |
| PICS bags (n=22) | 100.9 | 4636 | PICS bags (n=45) | 100.8 | 4649 |
| Agro Z (n=2) | 120.0 | 4000 | Agro Z (n=2) | 100 | 5000 |
| Plastic bottles (n=1) | 10 | 2500 | Plastic bottles (n=0) | - | - |
| Chemical use | Number of bags treated* | Cost (TZS)* | Chemical use | Number of bags treated* | Cost (TZS)* |
| Insecticide treatment (n=14) | 1.6 | 3518 | Insecticide treatment (n=75) | 2.3 | 3897 |

*All values expressed as means

6. Discussion:

From these findings, it is evident that more farmers store bean seed than maize seed. Most farmers use hybrid maize and rely on agrodealers for supply. However, some farmers do store hybrid maize seed for planting during the following season. Training farmers on hybrid seed management is important, such as the benefits to buying hybrid seeds every year. Farmers need to be made aware that saving hybrid maize seed from their harvest for planting the following season would significantly decrease yields. For beans, most farmers store bean seed for their own use or buy it from local markets. Since the majority of farmers (>92%) store their bean seed between three to six months, there is a need for improved and more cost-effective seed storage methods. High-quality bean seeds could help farmers be far more productive.

Farmers are aware of the importance of seed storage and are using different technologies to protect their crops, including insecticides and hermetic technologies. When looking at costs, hermetic bags (PICS) are cost-effective compared to woven bags plus insecticides when reused two or more times. There is a need to build awareness about bean seed storage since farmers are using subjective methods for moisture measurement before storage and rely heavily on insecticides. Most farmers lack proper

training of handling insecticides for grain storage. Additionally, promoting safer alternatives for seed and grain storage is important.

B. Agrodealers and Seed Producers

1. Postharvest management by agrodealers and seed producers

The survey questionnaire for agrodealers and seed producers can be found in Annex C. Table 6 below shows a side-by-side comparison of the summary of seed storage practices among agrodealers and seed producers. **For the 40 agrodealers** interviewed, 68% store seed which is mostly hybrid maize, while 15% store a small amount of improved bean varieties; the agrodealers mostly practice short-term storage of less than three months (78%) and experience loss due to insects (11%) and rodents (15%). To mitigate losses, the majority of dealers take no action (78%), most likely because the seed is already treated and packaged by seed producers. **For the nine seed producers** interviewed, all produced mainly hybrid maize (78%), open pollinated varieties (OPVs, 55.6%) and improved bean varieties (78%). The majority of producers store seed for three to six months (67%), and experience loss due to insects (33%) and rodents (11%). To deal with losses, the producers apply pesticides (89%).

Table 6. Postharvest storage management of seed used by agrodealers and seed producers in Northern Tanzania

| AGRODEALERS | Percent | SEED PRODUCERS | Percent |
|--|---------|--|---------|
| Do you store seed (n = 40) | | Do you store seed (n = 9) | |
| Yes | 67.5 | Yes | 100.0 |
| No | 32.5 | No | 0.0 |
| Type of maize seed stored (n= 27) | | Type of maize seed stored (n=9) | |
| Hybrid maize | 100.0 | Hybrid maize | 77.8 |
| Local maize varieties | 0.0 | Local maize varieties | 0.0 |
| Open Pollinated Varieties (OPVs) | 59.3 | Open Pollinated Varieties (OPVs) | 55.6 |
| Type of bean seed stored (n= 27) | | Type of bean seed stored (n= 9) | |
| Local bean variety | 0.0 | Local bean variety | 0.0 |
| Improved bean variety | 14.8 | Improved bean variety | 77.8 |
| Typical storage duration bean seed after harvest (n = 27) | | Typical storage duration seed after harvest (n = 9) | |
| Less than 3 months | 77.8 | Less than 3 months | 22.2 |
| Between 3-6 months | 22.2 | Between 3-6 months | 66.7 |
| Between 6-9 months | 0.0 | Between 6-9 months | 0.0 |
| Between 9-12 months | 0.0 | Between 9-12 months | 11.1 |
| More than 12 months | - | More than 12 months | - |

2. Seed handling and storage by agrodealers and producers

Some seed producers (22.2%) are using mechanical dryers for seed storage. This is due to unfavorable weather conditions during harvest, combined with the need to ensure seed quality during storage. About 90% of seed producers relied on the sun to dry their seed. Two-thirds of seed producers used moisture meters to assess moisture content. Compared to agrodealers, seed producers mentioned insects as a greater source of seed loss. Additionally, more seed producers use insecticides compared to agrodealers to combat pests, as seed producers store seed for a longer time compared to agrodealers.

Table 6. Seed drying and moisture assessment methods, sources of loss and seed protection methods used by agrodealers and seed producers in Northern Tanzania.

| | Agrodealers | Seed producers |
|----------------------------------|--------------------|-----------------------|
| Drying methods | n=40 | n=9 |
| Mechanical dryers | -- | 11.1% |
| Sun dry | -- | 77.8% |
| Both | -- | 11.1% |
| Moisture Assessment | n=40 | n=9 |
| Biting the grain | -- | 22.2% |
| Moisture meter | -- | 66.7% |
| Salt method | -- | 11.1% |
| Source seed loss | n=27 | n=9 |
| Humidity/mold | -- | -- |
| Insects | 11.10% | 33.3% |
| No seed storage losses | 74.10% | 55.6% |
| Rodents | 14.80% | 11.1% |
| Seed protection methods | n=27 | n=9 |
| Botanicals (plant extract, etc.) | No data | No data |
| Do nothing | 77.80% | 11.1% |
| Hermetic/ airtight methods | 11.10% | 0.0% |
| Pesticides/chemicals | 59.30% | 88.0% |

3. Discussion: agrodealers and seed producers

The findings suggest that seed producers store seed for 3-6 months after harvest, and based on prior knowledge, they then sell it to agrodealers who (mostly) store it for less than three months. The majority of agrodealers noted that they did not have storage losses because they store for a short time period (purchase the seed for sale a few months before the planting season). Slightly more than half of seed producers mentioned that seed loss was not an issue because they rely heavily on insecticides to protect seed. Similar to farmers, building more awareness about hermetic storage among these groups (especially seed producers) would help improve seed storage and reduce the reliance on insecticides. There is an opportunity to use agrodealers/seed producers as retailers of hermetic storage since many farmers complain about availability of storage technologies. Agrodealers and seed producers can sell hermetic technologies to farmers since they already are selling hybrid seed to the farmers. This would provide additional business opportunities for these private sector actors (beyond seed) and improve the availability of safer storage technologies among farmers.

V. Next Steps

The following three key recommendations should be supported: (i) Improve seed and storage technologies; Build awareness on the need and capacity of the private sector to increase the availability of improved seed and hermetic storage technologies; (ii) Maintain seed quality; Strengthen the private sector capacity in proper handling and storing seed; and (iii) Train farmers to properly handle and store local and improved bean seed varieties.

VI. References

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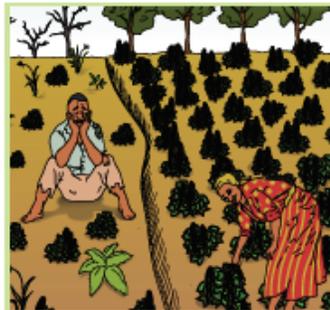
VII. Annexes

Annex A. Hermetic Seed Storage Poster

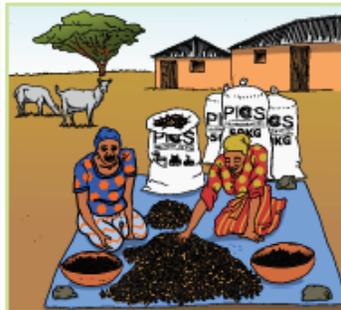


Global Supporting Seeds Systems for Development

HIFADHI YA MBEGU KUTUMIA MIFUKO YA PICS



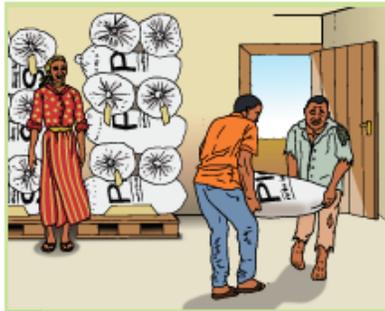
1 Mbegu bora lazima ipandwe, ivunwe na ichekatwe kwa utaratibu sahihi.



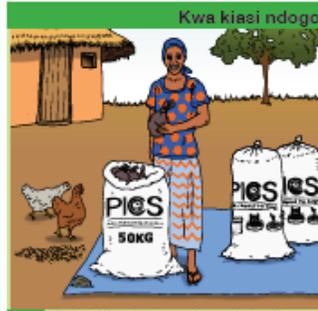
2 Mbegu bora lazima iwe safi na kavu. Kauka hadi kufikia kiwango cha unyevu kinachopendekezwa (mf. asilimia 13 kwa mahindi).



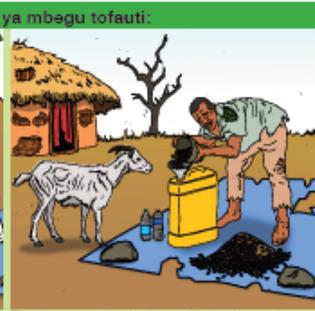
3 Tumia vyombo visivyopitisha hewa (mf. mifuko ya PICS, madumu, chupa, na kadhalika) kwa kuhifadhi mbegu.



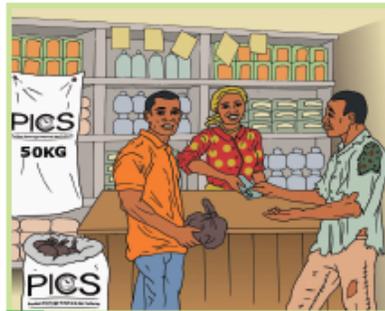
4 Kwa kiasi kikubwa tumia mifuko ya PICS.



5 Weka kila aina ya mbegu tofauti katika mifuko midogo midogo kisha kuziweka ndani ya mfuko wa PICS.



Au Tumia vyombo visivyopitisha hewa kama madumu au chupa za plastiki za maji. Jeza mbegu hadi juu ili kuhakikisha hama hewa iliyobaki ndani kisha fungu.



6 Kwa wauza mbegu, weka mbegu ndani ya mifuko midogo midogo (k.m. kilo 1 au zaidi) kisha uziweke ndani ya mfuko wa PICS ili kuzula kushambuliwa na wadudu.

Mapendekezo

- Tumia mfuko wa PICS ya ujazo wa kilo 25 au 50 kuhifadhi mbegu
- Fungasha mbegu karibu na au ndani ya sehemu ya kuhifadhi.
- Katika kila kifungashio andika aina ya mbegu, jina na mwaka iliyovunwa
- Panga kwa kubebesha mifuko ya PICS kwenye sehemu iliyolnuilwa (mf. Kutu mia boriti, chaga) na pia mbali na kuta
- Uahifadhi mifuko ya PICS mahali penye mionzi ya jua la moja kwa moja
- Kagua mbegu iliyohifadhiwa angalau mara moja kila mwezi
- Fanya majaribio ya uotaji wa mbegu kabla ya kupanda au kuuzwa

Kuhifadhi salama ni kuzuia njaa

Ukweli kuhusu uhifadhi wa mbegu

- Uhifadhi wa mbegu kwa kutumia vyombo visivyopitisha hewa ni njia salama ya kutunza ubora wa mbegu
- Mbegu zinahitaji kiasi kidogo cha hewa ya oksijeni katika kipindi cha uhifadhi mf. chini ya asili mia 2 cha hewa ya oksijeni baada ya miezi sita ya uhifadhi
- Hata kama mbegu zimeshambuliwa, ni mara chache kiasi cha hewa ya oksijeni hupungua zaidi ya asilimia 5, kiwango ambacho kinatoa kutunza ubora wa mbegu

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Annex B. Questionnaire Farmers

Survey Questionnaire on seed storage in Northern Tanzania

District

Community

Farmer's group name.....

Location of farmer's group:

Geographical Coordinate of the community: (automatic data)

PERSONAL DATA

1. Name of the enumerator.....
2. Code of the respondent:
3. Gender of the respondent: 1. Male 0. Female
4. Year of birth:
5. Marital Status
 - Single
 - Married
 - Widower
 - Divorced/Separated
6. Size of the household (total number)
 - Children between 0-5 years
 - Children Between 6-14 years
 - Adults between 15-64 years
 - Above 64 year
7. Level of Education
 - None
 - Literacy
 - Primary school
 - High (Secondary) School
 - Post-secondary (university, trade school)
8. Which other occupation are you engaged in?
 - Formal employment/Service/salaried wage e.g. teaching, Ngo
 - Small Trader
 - None
9. Are you member of a farmers group?
 - Yes
 - No
10. If Yes, What kind of group?
 - Production group
 - Marketing group
 - Both production and marketing
 - Other, specify

ACCESS TO INFORMATION ON SEED STORAGE

11. Do you receive information on seed management (acquisition, multiplication, renewal, storage)?
 - Yes
 - No
12. If yes, what is the most important source of information? (Select most important source)
 - Research and extension (Government, International research centers (e.g CIAT), University)

- Seed dealers/producers/ multipliers
 - Farmers' groups
 - Large grain buyers
 - Neighbors & friends
 - Others (specify)
13. If yes, how many times in the past one year have you been in contact with the most important source of information above (#)
14. If yes, how do you receive the information? (Rank the top two the most important- 1 and 2)
- Field days/Trainings/meetings
 - Print media-Written materials/Reading
 - Other Media (radio, TV, etc.)
 - ICT-mobile phone SMS
 - Others (specify)
15. Do you have a cellphone?
- Yes
 - No
16. Do you receive agricultural information on your cellphone?
- Yes
 - No

GRAIN PRODUCTION:

17. What crops do you produce?
- Only maize
 - Only beans
 - Both, maize and beans

18. Provide the grain production information for maize and beans in the previous season of 2018/2019

| Crop | Area farmed (ha) | Qty of seed planted (kg/ha) | Qty harvested (Kg) | Qty sold (kg) | Qty consumed at home (kg) | Qty given as gift (kg) | Qty lost/rot(kg) | Qty Stored (Kg) |
|-------|------------------|-----------------------------|--------------------|---------------|---------------------------|------------------------|------------------|-----------------|
| MAIZE | | | | | | | | |
| BEANS | | | | | | | | |

19. Reason for producing and production per year (fill for each crop)

| Crop | Why do you grow beans (choose most important)? | How many cropping cycles (pick the most important) |
|-------|--|--|
| MAIZE | <ul style="list-style-type: none"> - Own consumption - Sale - Animal feed - Both | <ul style="list-style-type: none"> - Once per year - Twice per year - Once every two years - Other (specify) |
| BEANS | | |

20. Provide information for buyers of the grain you produce? (fill for each crop)

| Crop | Do you sell to buyers | Type of buyers (pick the most important) | Buyer supply seed? (pick) | How often? (pick the most important) |
|------|-----------------------|--|---------------------------|--------------------------------------|
| | | | | |

| | | | | |
|-------|---------------|---|------------------------------------|--|
| | | | the most important) | |
| MAIZE | - Yes - No | - Seed companies - Food processors - Retailers/wholesalers/Supermarkets | - For free - Buy - On credit | - Every season - Every two seasons - Every three seasons - Every four seasons or more |
| BEANS | - Yes - No | - NGO e.g-WFP - Others, specify | | |

SEED ACQUISITION

21. How do you access seed for the beans you grow?

| Type of beans (pick the most important) | Name of most important variety | Most important reason for preference of the purchased bean seed variety? | Quantity purchased (kg) Quantity purchased (kg) | How do you obtain seed | From where | How often |
|---|--------------------------------|--|--|----------------------------------|--|--|
| - Local bean variety - Improved bean variety | | - Don't know - High yield - Grain quality (taste, nutrition, etc.) - Resistance/tolerance to drought and pests - Early maturing (Short cycle) - Other (specify) | | - produce own - buy - free | - Agro dealers/Seed dealers - Seed producers (Research organizations, government research, seed companies) - Farmer groups - Farmers in local markets - Local NGOs - Others | - Every season - Every two seasons - Every three seasons - Every four seasons or more |

22. How do you access seed for the maize you grow? (fill for each type of maize)

| Type of seed (pick the most important) | Name of most important variety | Most important reason for preference of the purchased bean seed variety? | Quantity purchased (kg) Quantity purchased (kg) | How do you obtain seed | From where | How often |
|--|--------------------------------|--|--|----------------------------------|--|--|
| - Local maize (OPVs) | | - Don't know - High yield - Grain quality (taste, nutrition, etc.) - Resistance/tolerance to drought and pests - Early maturing (Short cycle) - Other (specify) | | - produce own - buy - free | - Agro dealers/Seed dealers - Seed producers (Research organizations, government research, seed companies) - Farmer groups | - Every season - Every two seasons - Every three seasons - Every four seasons or more |
| - Hybrid maize | | | | | | |

| | | | | | | |
|--|--|--|--|--|--|--|
| | | | | | <ul style="list-style-type: none"> - Farmers in local markets - Local NGOs - Others | |
|--|--|--|--|--|--|--|

SEED STORAGE

23. What seeds do you store?

- Only maize
- Only beans
- Both, maize and beans

24. Maize Seed Storage? (fill for each type of maize)

| Type of maize seed | Reason for storage | Quantity stored (kg) | Typical storage duration | From where | How often |
|--------------------|--|----------------------|--|---|--|
| Local maize (OPVs) | <ul style="list-style-type: none"> - Own use - For sale | | <ul style="list-style-type: none"> - Less than 3 months after harvest - Between 3-6 months after harvest | <ul style="list-style-type: none"> - Agro dealers/ Seed dealers - Seed producers (Research organizations, government research, seed companies) - Farmer groups | <ul style="list-style-type: none"> - Every season - Every two seasons - Every three seasons - Every four seasons or more |
| Hybrid maize | <ul style="list-style-type: none"> - Higher prices of hybrid maize seed - Unavailability of hybrid maize seed - Other (specify) | - | <ul style="list-style-type: none"> - Between 6-9 months after harvest - Between 9-12 months after harvest - More than 12 months after harvest | <ul style="list-style-type: none"> - Farmers in local markets - Local NGOs - Others | |

25. Bean Seed Storage?

| Type of bean seed (pick the most important) | Reason for Storage (pick the most important) | Quantity stored (kg) | Typical storage duration | From where | How often |
|---|--|----------------------|--------------------------|------------|-----------|
| | | | | | |

| | | | | | |
|---|---|--|--|---|--|
| <ul style="list-style-type: none"> - Local bean variety - Improved bean variety | <ul style="list-style-type: none"> - Own use - For sale | | <ul style="list-style-type: none"> - Less than 3 months after harvest - Between 3-6 months after harvest - Between 6-9 months after harvest - Between 9-12 months after harvest - More than 12 months after harvest | <ul style="list-style-type: none"> - Agro dealers/ Seed dealers - Seed producers (Research organizations, government research, seed companies) - Farmer groups - Farmers in local markets - Local NGOs - Others | <ul style="list-style-type: none"> - Every season - Every two seasons - Every three seasons - Every four seasons or more |
|---|---|--|--|---|--|

26. Seed storage challenges and protection (fill for each crop)

| Crop | What determines the quantity of seed that you store? (select most important) | What is the most important source of seed storage losses? | What is your primary method for seed protection? (<i>Select most important</i>) |
|-------|--|---|---|
| MAIZE | <ul style="list-style-type: none"> - Quantity of seed you produced - Limited availability of seed in markets | <ul style="list-style-type: none"> - No seed storage losses - Insects - Rodents - Humidity/mold - Others (specify) | <ul style="list-style-type: none"> - Do nothing - Pesticides/chemicals - Traditional (underground storage, ash, smoke) - Botanicals (plant extract, etc.) |
| BEANS | <ul style="list-style-type: none"> - Demand from seed buyer - Share with relatives (family needs) - Production for large buyers | | <ul style="list-style-type: none"> - Hermetic/ airtight Methods (hermetic bags, jerricans, silos, bottles) - Others (specify) |

| | | | |
|--|------------------|--|--|
| | - Others specify | | |
|--|------------------|--|--|

MOISTURE MEASUREMENT AND HERMETIC BAGS USE

27. How do you primarily dry and assess moisture content of the seed? (Select most important)

| Crop | Drying method | Measurement of moisture content |
|-------|--|--|
| MAIZE | Sun dry Indoor over cooking place (Smoke) Hang indoor and outside (on walls, etc.) Others (specify) | Moisture meter Salt method Sound of shaken grain Biting the grain I do not measure Others (specify) |
| BEANS | | |

28. Which of the following containers do you use to store maize seed? (please also indicate the capacity and the price you pay for the container you use) (pick the most important for each crop).

| Container for seed | MAIZE/BEAN | Capacity (liters or kg) | Price (Shillings) |
|--------------------------|------------|-------------------------|-------------------|
| Woven polypropylene bags | | | |
| Jute bags | | | |
| Jerry cans | | | |
| Clay pots | | | |
| Calabashes/gourds | | | |
| Barrels | | | |
| Metal silos | | | |
| Others (specify) | | | |

29. Which of the following seed protection methods do you use the most to store seed? (please also indicate the capacity and the price you pay for the technology you use) (pick the two important for each crop).

| Protections | MAIZE/BEANS | Capacity (liters or kg) | Price (Shillings) |
|----------------------|-------------|-------------------------|-------------------|
| PICS bags | | | |
| AgroZ bags | | | |
| Plastic/glass bottle | | | |
| Jerricans | | | |
| Silos | | | |
| Insecticides | | # of bags treated | |
| Others (specify) | | | |

Annex C. Questionnaire seed dealers/seed producers

Questionnaire for seed dealers/producers/multipliers

District.....

Company name.....

Geographical Coordinate: (automatic data)

SEED ENTERPRISE INFORMATION

1. Name of the enumerator:
2. Code of the respondent:
3. Affiliation
 - Seed dealer/Agro dealer
 - Seed producer/multiplier
 - Government employee (e.g. TARI)
 - International/local Development Organization (e.g. CIMMYT/CIAT, NGO's)
 - Seed companies
 - Other, specify
4. Current position in the company.....
5. How many years have you been in seed business at your current position?Number of years

IF AGRODEALER/SEED DEALER/SEED COMPANY

6. If seed dealer/agro dealer, what is your main line of business?
 - Hardware
 - General Merchandise
 - Agro-Inputs (seed, fertilizer, chemicals)
 - Other, specify
7. For what CROP do you primarily sell seed?
 - Maize
 - Bean
8. For Maize, What type of maize seed do you primarily sell? (select one)
 - Hybrid
 - OPVs
 - Others, specify
9. For bean, what type of bean seed do you primarily sell? (select one)
 - Local varieties
 - New/Improved varieties
 - Others, specify
10. How is the seed is provided to farmers?
 - Free of charge
 - Sold
 - As input as contracted seed producers
 - Other, specify
11. Who supplies you with the primarily seed you sell? (Rank two most important)
 - Produce own
 - Buy from farmers and recondition
 - Seed producers/multipliers
 - Research/extension organizations (government, CIAT, etc.)
 - NGOs/Projects
 - Seed companies (e.g. Seed co, Kibo, etc.)

- Others, specify
- 12.** How often do you receive seed from your supplier?
- Every season (2 per year)
 - Monthly
 - Every 6 months
 - Every year
 - Every 2 years
 - Every 3 years
 - Other specify
- 13.** When do you buy seed you sell?
- Less than 3 months before planting
 - Between 3-6 months before planting
 - More than 6 months before planting
- 14.** Who are the customers of the seed you sell? (Rank two most important)
- Individual farmers
 - Farmers groups/associations
 - Government
 - NGOs/Relief agencies/projects
 - Others (specify)
- 15.** How do you make farmers aware of new seed?
- Demonstration (field days, etc.)
 - Extension services
 - Radios
 - TV
 - Newspapers)
 - Social media (Facebook, twitter or linked in, WhatsApp group)
 - Phone (Sms/bulk sms)
 - Other specify
- 16.** What channels do you use for providing seed information to farmers?
- Farmer groups
 - Fields days
 - Media (radio, flyers, TV, etc.)
 - Markets
 - Other, specify
- 17.** What are major challenge in providing new seed to farmers?
- Limited resources (transportation, etc.)
 - Low participation of farmers
 - Inappropriate timing of events
 - Limited knowledge of farmers
 - High cost of seeds
- 18.** How to you facilitate the availability of new seed to farmers?
- Give free samples (starter packs)
 - Give seeds to farmers on credit
 - Contract farmers to produce seeds for you (QDS seeds)
 - Have demonstration gardens in farmers villages
 - Collect and buy for farmers
- 19.** On average, what is the inventory of seed that you deal with per season?

| Crop | Variety | Quantity stocked (kg) | Quantity sold (kg) | Fate of unsold inventory |
|-------|----------|-----------------------|--------------------|--|
| Maize | Local | Less than 100 kg | Less than 100 kg | Store Return to supplier Other, specify |
| | | 100 - 500 kg | 100 - 500 kg | |
| | | 501 -1000 kg | 501 -1000 kg | |
| | | 1000- 5000 kg | 1000- 5000 kg | |
| | | Over 5000kg | Over 5000 kg | |
| | Hybrid | | | |
| Beans | Local | | | |
| | Improved | | | |

20. Do you store your seed before it is sold?

- Yes
- No

21. If NO, do you store unsold seed?

- Yes
- No

22. If YES on Q 17, for how long do you store your seed?

- Less than 3 months before planting
- Between 3-6 months before planting
- More than 6 months before planting

23. Which of the following containers do you use to store primary seed for sale? (please rank 2 most important- indicate the capacity and the price you pay for the container you use)

| Container for seed | Yes/no | Capacity (liters) | Price (Shillings) |
|--------------------------|--------|-------------------|-------------------|
| Woven polypropylene bags | | | |
| Jute bags | | | |
| Jerry cans | | | |
| Metal silos | | | |
| Others (specify) | | | |

24. Have you had any losses during seed storage?

- Yes
- No

25. If yes, what is the most important source of seed storage losses?

- Insects
- Rodents
- Humidity/mold
- Others (specify)

26. What is your primary method for seed protection? (Rank two most important)

- Do nothing
- Pesticides/chemicals
- Traditional (underground storage, ash, smoke)
- Botanicals (plant extract, etc.)
- Hermetic/ airtight Methods (hermetic bags, jerricans, silos, bottles)
- Others (specify)

27. If you use hermetic/airtight methods to store primary seed, please specify which one? (Rank most important)
- Hermetic bags
 - Jerricans
 - Silos (metal or plastic)
 - Plastic/glass bottles
 - Other specify
28. Which of the following seed protection method do you use to store seed? (please also indicate the capacity and the price you pay for the technology you use)

| Protections for seed | Crop (Maize or beans) | Yes/No | Capacity (liters) | Price (Shillings) |
|----------------------|-----------------------|--------|-------------------|-------------------|
| PICS bags | | | | |
| AgroZ bags | | | | |
| Plastic/glass bottle | | | | |
| Jerricans | | | | |
| Silos | | | | |
| Insecticides | | | # of bags treated | |
| Others (specify) | | | | |

IF SEED PRODUCERS/MULTIPLIERS

29. If seed producer/multiplier, are you involved in any other business?
30. For what CROP do you primarily produce/multiply seed?
- Maize
 - Bean
31. For Maize, what type of maize seed do you primarily produce/multiply? (select one)
- Hybrid
 - OPVs
 - Others, specify
32. For bean, what type of bean seed do you primarily produce/multiply? (select one)
- Local varieties
 - New/Improved varieties
 - Others, specify
33. Who supplies you with the seed that you use to produce/multiply seed?
- Government research institutes
 - International research centers
 - Seed companies
 - Others, specify
34. How often do you receive seed from your supplier?
- Every season (2 per year)
 - Monthly
 - Every 6 months
 - Every year
 - Every 2 years
 - Every 3 years

- Other specify
- 35.** When do you sell seed you produce/multiply?
- Less than 3 months before planting
 - Between 3-6 months before planting
 - More than 6 months before planting
- 36.** Who buys the seed that you produce/multiply?
- Agro dealers/ Seed dealers
 - Farmers groups/associations
 - Government
 - NGOs/Relief agencies
 - Seed companies (e.g. Seed co, Kibo, etc.)
 - Others (specify)
- 37.** What channels do you use for providing seed to farmers?
- Farmer groups
 - Fields days
 - Media (radio, flyers, TV, etc.)
 - Markets
 - Other, specify
- 38.** How do you make farmers aware of new seed?
- Demonstration (field days, etc.)
 - Extension services
 - Radios
 - TV
 - Newspapers)
 - Social media (Facebook, twitter or linked in, WhatsApp group)
 - Phone (SMS/bulk SMS)
 - Other specify
- 39.** What channels do you use for providing seed information to farmers?
- Farmer groups
 - Fields days
 - Media (radio, flyers, TV, etc)
 - Markets
 - Other, specify
- 40.** What are major challenge in providing new seed to farmers?
- Limited resources (transportation, etc.)
 - Low participation of farmers
 - Inappropriate timing of events
 - Limited knowledge of farmers
 - High cost of seeds
- 41.** How to you facilitate the availability of new seed to farmers?
- Give free samples (starter packs)
 - Give seeds to farmers on credit
 - Contract farmers to produce seeds for you (QDS seeds)
 - Have demonstration gardens in farmers villages
 - Collect and buy for farmers
- 42.** On average, what is the inventory of seed that you deal with per season?

| Crop | Variety | Quantity stocked (kg) | Quantity sold (kg) | Fate of unsold inventory |
|-------|----------|-----------------------|--------------------|--|
| Maize | Local | Less than 100 kg | Less than 100 kg | Store Return to supplier Other, specify |
| | | 100 - 500 kg | 100 - 500 kg | |
| | | 501 -1000 kg | 501 -1000 kg | |
| | | 1000- 5000 kg | 1000- 5000 kg | |
| | | Over 5000kg | Over 5000 kg | |
| | Hybrid | | | |
| Beans | Local | | | |
| | Improved | | | |

43. How do you dry the seed that you produce/multiply? (Select most important)

- Sun drying
- Mechanical drying (Dryers)
- Others(specify)

44. How do you determine if your bean seed is dry? (Select most important)

- Moisture meter
- Salt method
- Sound of shaken grain
- Biting the grain
- I do not measure
- Others (specify)

45. Do you store the seed that you produce/multiply?

- Yes
- No

46. If NO, do you store unsold seed that you produce or multiply?

- Yes
- No

47. If Yes to Q28 or Q29, for how long do you store your seed?

- Less than 3 months before planting
- Between 3-6 months before planting
- More than 6 months before planting

48. Which of the following containers do you use to store primary seed for sale? (please rank 2 most important- indicate the capacity and the price you pay for the container you use)

| Container for seed | Yes/no | Capacity (liters) | Price (Shillings) |
|--------------------------|--------|-------------------|-------------------|
| Woven polypropylene bags | | | |
| Jute bags | | | |
| Jerry cans | | | |
| Metal silos | | | |
| Others (specify) | | | |

49. Have you had any losses during seed storage?

- Yes
- No

50. If yes, what is the most important source of seed storage losses?

- Insects

- Rodents
 - Humidity/mold
 - Others (specify)
51. What is your primary method for seed protection? (Rank two most important)
- Do nothing
 - Pesticides/chemicals
 - Traditional (underground storage, ash, smoke)
 - Botanicals (plant extract, etc.)
 - Hermetic/ airtight Methods (hermetic bags, jerricans, silos, bottles)
 - Others (specify)
52. If you use hermetic/airtight methods to store primary seed, please specify which one? (Rank most important)
- Hermetic bags
 - Jerricans
 - Silos (metal or plastic)
 - Plastic/glass bottles
 - Other specify
53. Which of the following seed protection method do you use to store seed? (please also indicate the capacity and the price you pay for the technology you use)

| Protections for seed | Crop (Maize or beans) | Yes/No | Capacity (liters) | Price (Shillings) |
|----------------------|-----------------------|--------|-------------------|-------------------|
| PICS bags | | | | |
| AgroZ bags | | | | |
| Plastic/glass bottle | | | | |
| Jerricans | | | | |
| Silos | | | | |
| Insecticides | | | # of bags treated | |
| Others (specify) | | | | |

Annex D. Region, districts, wards, villages and number of farmers, seed dealers and seed producers interviewed in three regions in Northern Tanzania.

| REGION | DISTRICT | WARD | VILLAGES | Farmers | Seed dealers | Seed producers | | |
|---------------|----------|-------------|--------------|---------------|--------------|----------------|---|--|
| Kilimanjaro | Hai | Weruweru | Kikavu Chini | 2 | | | | |
| | | | Rundugai | Kaway | 19 | 4 | | |
| | | | | Mkalama | 14 | 1 | | |
| | | | | Rundugai | 19 | | | |
| | | | Masama | Mungushi | 1 | | | |
| | | | Kusini | Kware | 2 | 1 | | |
| | | Mkombozi | | 11 | | | | |
| | | | Mnadani | Kimashuku | 14 | | | |
| | | Shiri Njoro | | 32 | | | | |
| | | | KIA | Sanya Station | | 1 | | |
| | | Siha | Ngarenairobi | Namwai | 19 | 2 | | |
| | | | | Ngarenairobi | 16 | | | |
| | | | | Mwangaza | 4 | | | |
| | | | Garagua | Wiri | 15 | 1 | | |
| | | | Karansi | Karansi | 12 | | | |
| | | | Makiwaru | Tindigani | 38 | 2 | | |
| | | | Songu | Ngumbaru | 11 | 1 | | |
| | | | Biriri | Naibili | 9 | 2 | | |
| | Manyara | Mbulu | Moringa | Daudi | 17 | 3 | | |
| | | | | Bargish | 10 | 5 | | |
| | | | Uwa | Uwa Bargish | 13 | 1 | | |
| | | | Tlawi | Tlawi | 35 | 2 | | |
| | | | Harsha | Bashay | 12 | 1 | | |
| | | | Dongobesh | Dongobesh | 12 | | | |
| Geterer | | | | 14 | | | | |
| | | | Tumati | Maretaduchini | | 1 | | |
| | | | Babati | Qwameyu | Qwameyu | 14 | 7 | |
| Gawal | | | | | 25 | 3 | | |
| | | Bashnet | | Long | | 1 | | |
| | | | | Bashnet | | 1 | | |
| | | Madunga | | Madunga | 17 | | | |
| | | Nar | Ayalagaya | 9 | | | | |
| | | Dareda Kati | Dareda | 26 | | | | |
| | Dabil | Maganjwa | 22 | | | | | |
| Arusha Region | | | | | | 9 | | |
| TOTAL | | | | 464 | 40 | 9 | | |

Annex E. Level of education and group membership of farmers interviewed in three regions in Northern Tanzania.

| Variable | District | | | | Overall (n=464) |
|---|-------------------|----------------|------------------|-----------------|--------------------|
| | Babati (n=113) | Hai (n=114) | Mbulu (n=110) | Siha (n=127) | |
| Level of Education | | | | | |
| None | 1.8% | 5.3% | 1.8% | 2.4% | 2.8% |
| Literacy (Religious education e.g Madrasa) | 0% | 0.9% | 0.9% | 1.6% | 0.9% |
| Primary school | 88.5% | 78.1% | 83.6% | 78% | 81.9% |
| High (Secondary) School (O-and A- level) | 6.2% | 12.3% | 11.8% | 11.8% | 10.6% |
| Tertiary (university, technical, vocational training) | 2.7% | 3.5% | 1.8% | 6.3% | 3.7% |
| Other (specify) | 0.9% | 0% | 0% | 0% | 0.2% |
| Farmers' group membership | | | | | |
| None | 73.5% | 57.9% | 70% | 41.7% | 60.1% |
| Both production and marketing | 6.2% | 12.3% | 0.9% | 11.8% | 8% |
| Marketing group | 0% | 0% | 1.8% | 0.8% | 0.6% |
| Other, specify | 0% | 4.4% | 0.9% | 1.6% | 1.7% |
| Production group | 9.7% | 25.4% | 16.4% | 26% | 19.6% |
| Village Saving (VICOBA) | 10.6% | 0% | 10% | 18.1% | 9.9% |